Leased Line via Mobile Infrastructure for Telemedicine in India

Bania, Ujjwal ; Peterson, Carrie Beth; Kyriazakos, Sofoklis

Published in:
International Federation for Medical and Biological Engineering Proceedings

DOI (link to publication from Publisher):
10.1007/978-3-642-21683-1

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Leased Line via Mobile Infrastructure for Telemedicine in India

Ujjwal Bania, Carrie Beth Peterson, and Sofoklis Kyriazokos

Center for TeleInFrastruktur (CTIF), Aalborg University, Aalborg, Denmark

Abstract— **Telemedicine is the use of information and communication technologies (ICT) to exchange medical information for the purpose of health care and health education. In the context of developing countries, good health care facilities are concentrated in the urban cities, while they are still lacking in rural communities with lower economies. Telemedicine provides a best solution to solve this disparity of health sectors between urban and rural areas. In rural areas of developing countries, a reliable communication link for telemedicine is one of the key challenges. In the recent years, there is an increasing growth of mobile communication in developing countries that has saturated in urban cities and now growing towards the rural areas. This article focuses in India as a developing nation and discusses the cost effective use of widespread mobile communications infrastructure for communication link for telemedicine in rural areas.**

Keywords — **Telemedicine, lease line, India, mobile communication.**

I. Introduction

Health care is a basic necessity for human beings and can be divided into primary care, secondary care, and tertiary care. Primary health care refers to the point of first consultation by the patient. Secondary health care refers to specialized medical care, such as cardiologists for heart related diseases. Tertiary health care deals with highly specialized care systems that require sophisticated equipment and multiple specialists. In the context of developing and under developed countries, secondary and tertiary services are concentrated in the urban cities and the rural areas that cover most part of the country are still served by minimal primary care health services. Medical professionals and doctors prefer to stay in the urban cities and hesitate to serve in the rural areas, due to the lack of medical resources for them to practice rural areas and the lack of incentive for them. In urban areas with more hospitals and care facilities, doctors can achieve the full financial and reputational gain as well as practice more professionally with the breadth of their medical expertise. This has resulted in the rural areas lacking basic health care and suffering due to simple diseases.

Telemedicine provides a good solution for this kind of scenario. Telemedicine connects the doctors and medical facilities to the patient at a distance through communication media. The mobile telecommunications services and internet bandwidths are becoming more available and affordable; in developing countries, these communication services have almost completely saturated the urban cities. Prompted by lower costs and increasing demand, telecommunications operators are expanding their networks towards rural villages to obtain more customers. In India, there is pervasive deployment of telecommunications and the tele-density (telephone per person) has already crossed 50% with the majority (93%) of the telecom market share covered by wireless mobiles [1].

India has a very good reputation in the medical sector in the subcontinent. In India, a new concept known as medical tourism has developed [2]. It attracts people from different parts of the world, both developing and developed countries, for pursuing medical treatment in India. People who can afford quality health care in the neighboring developing countries like Nepal often go to India for treatment. While from the developed countries, people go to India for quality medical treatment at cheaper rates.

On one side, India is attracting people from outside the country for quality healthcare, while on the other side, India is not able to provide primary healthcare to its own citizens in some of the poorer villages. This paper briefly explores different types of telemedicine that have been in used in India and gives a cost effective solution to use mobile communication network for telemedicine in the rural parts of India. The rest of the paper is structured as follows: Section II describes the brief background of India, Section III describes standardization, Section IV proposes a solution for communication link in telemedicine, Section V lists the benefits of the proposed solution, and Section VI contains the discussion.

II. Background of India

A. Demographic figures of India

India is a developing country covering a total area of 3,287,268 square kilometers with around 1.1 billion living in it. India has a rich, ancient history of medical and holistic health. Before the modern medical facility, *ayurbedic* medicine was practiced in India. *Ayurbedic* medicine is popular for its minimal side effects and, over the years, western countries have also taken interest in traditional health practices.

In India, nearly 70% of the population live in rural areas that lack proper health care services; 27.5% of the population lives under the poverty line (earning less than 1$

K. Dremstrup, S. Rees, M.Ø. Jensen (Eds.): 15th NBC on Biomedical Engineering & Medical Physics, IFMBE Proceedings 34, pp. 129–132, 2011.
www.springerlink.com

per day per person)[3]; and 90% of secondary and tertiary healthcare facilities are in cities away from rural areas. Furthermore, the doctor to population ratio in India is an unacceptable 1:1722 as per Medical Council of India [4].

B. Overview of telemedicine in India

Telemedicine is not new for India. There are many telemedicine systems running in India, several of which are described in this section. In India, telemedicine programs are supported by both governmental and private parties. Government bodies include Department of Information Technology, Indian Space Research Organization (ISRO), NEC Telemedicine program for North-Eastern states, State governments etc. And private parties include Apollo Hospitals Group, Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Asia Heart Foundation etc.

Apollo Hospital Group started in 1987 and is now one of largest private healthcare groups in Asia. It delivers turnkey healthcare facilities, like building a small primary care hospital to super specialty hospitals. Its network is wide spread with 50 hospitals in and outside India. Apollo Telemedicine Networking Foundation (ATNF) is the telemedicine branch of the Apollo Hospitals Group. It is credited with being the first to setup a Rural Telemedicine centre in 1999 in Aragonda (a remote village in mid India). The telemedicine services provided by ATNF are Tele-Radiology, Tele-Dermatology, Tele-Pathology, Tele-Cardiology, Remote ICU Monitoring, Ambulance Monitoring, Mobile Telemedicine Unit, Electronic Health Record, etc [5]. ATNF has collaborated with CISCO to expand the telemedicine services in India [6] in May, 2010. Collaboration basically uses HealthPresence™, a product of CISCO, for the telemedicine services that will be provided by ANTF. In this system, doctors do not have to go to the telemedicine centers; rather, the doctors can use their laptop through the internet to check up their patient at remote telemedicine center assisted by a nurse from anywhere.

Indian Space Research Organization (ISRO) is a government organization dealing with space technologies in India. ISRO started a telemedicine project in 2001 to introduce the telemedicine facility to the rural areas. ISRO mainly uses INSAT Satellites as a means of communication for telemedicine. Satellites provide two main advantages: (1) it is reliable and (2) easy to reach in remote places. Though satellite is costly solution, government support has made it possible to connect to the rural areas. Using satellite, ISRO's Telemedicine Network has connected 306 rural hospitals and 16 mobile telemedicine units to 60 super specialty hospitals located in metropolitan cities [7].

C. Telecom Sector in India

The Department of Telecommunications under the Ministry of Telecommunication and IT targeted the deployment of 500 million mobile telephones by 2010 and this was achieved in September, 2009. This prior achievement of tele-density is due to the involvement of the private sector in the telecom market.

Wired line services like POTS and ISDN do not have much penetration in the rural areas of India. It consists of only 7% of the total tele-density over the entire country. Landline telephone lines are decreasing in India as is the trend in the rest of the world, largely due to the high cost of copper cables and their fixed nature, and furthermore, due to the low cost deployment in wireless telephone services.

On the other hand, there is an exponential penetration of wireless systems like GSM and CDMA networks in India and mobile tele-density is expected to reach 100% by the year 2015. The mobile tele-density in the urban areas has already saturated to 110 % and in the rural area it is 21% as of December, 2009. There are 10 different telecom operators all over the country [8], and they should now target the rural areas for the new customers.

III. Standardization

Telemedicine faces technological issues in facilitating healthcare solutions that are easily accessible and available to cover most of the country. Telemedicine facilities have been developed by different vendors using various types of software and hardware, many of which were created specifically for that facility or project. Like any other technology, telemedicine needs to be standardized by a governing body for interoperability among different vendors for the correct representation and utilization of medical services.

In India, the Ministry of Health and Family Welfare has formed a National Task Force that includes the Department of Information Technology, Union Ministries of Health, ICT, the Indian Space Research Organization (ISRO), the Medical Council of India, and various hospitals that practice telemedicine to address the standardization issues of telemedicine in India[9]. Standardization will benefit all the stakeholders in telemedicine field by facilitating regulations for interoperability among different vendors, which in turn allows the telemedicine users to choose the best suited vendor for their purposes. However, standardization is a much larger issue than the scope of this paper as there has to be standards in both in the medical ontology used and the protocols used in communication.

IV. Overview of Mobile Infrastructure

A. Mobile Network

Mobile networks consist of two parts, namely Base station subsystem (BSS) and Network Switching Subsystem (NSS). NSS also known as the core part which performs the call control function and service control function for the entire mobile network. NSS is normally located in urban areas and consists of many network elements like HLR, MSC, VLR, SMSC, SGSN, and GGSN, etc.

BSS is also known as the radio part and consists of two types of network elements: Base Station Controller (BSC) and Base Transceiver Station (BTS). BSC connects to the NSS and controls the BTS that are scattered over a region. BTS communicates with the user's mobile handset at frequencies 900, 1800, or 1900 MHz. Each BTS site consists of antenna mounted on mast. BTS are scattered over different regions for mobile service coverage. BTS are separated at 8 to 10 km to provide good wireless services in sparsely populated rural areas, while in densely populated urban areas, they may be as close as 300 meters for higher numbers of users. Expansion of mobile service coverage requires expansion in the number of BTS sites over the region.

B. Transmission network

Besides the various mobile network elements discussed briefly above, a transmission network is required that can provide a very reliable communication link between different sites in the network. The transmission network usually consists of equipment like SDH and PDH that use microwave and optical fiber; sometimes satellite is also used as the mode of transmission. All the BTS sites are connected to BSC and to the core network through communication links provided by this transmission network. Expansion of BTS sites for mobile service coverage in an area requires the side by side expansion of transmission network. This transmission network can be shared for other purposes like leased line for telemedicine.

C. Leased line service

Leased line is a communication link between any two places. Normally for telemedicine, lease line service is required between the hospitals for exchanging medical information. Hospitals may be located in rural areas with primary healthcare and urban areas with secondary and tertiary healthcare.

The expansion of mobile services requires the expansion of BTS sites with a well-established transmission network. Telecom service providers should enhance transmission networks in each BTS site with the provision of leased services. These leased services can be used to connect the hospitals or healthcare units of the remote areas. Since the BTS sites in remote villages are scattered 8 to 10 km, it will be easy to connect the hospital or healthcare unit and the BTS site via copper, optical, or microwave. Once the remote hospital is connected to the telecom service provider's network, the leased line connectivity should be made to the specialty hospitals in metropolitan cities through the transmission network.

The authors would recommend leased bandwidth connectivity from telecom service providers for the purpose of telemedicine as the most cost-effective solution for India. Telemedicine equipment often requires a longer, stable connection to a fixed number of systems, for example, a rural hospital connected to a super specialty hospital; leased line connections suit this type of network requirement for both real-time and store and forward type of telemedicine applications.

V. Financial Benefits

A. Satellite

The proposed solution for using the mobile network will significantly reduce the cost of communication links as it will be an option to choose from the satellite link in the rural areas. A satellite communication link costs a higher monthly fee for satellite bandwidth and a higher amount of initial investment. While the cost of leased line via mobile network for the same bandwidth will be significantly less monthly cost and even lesser initial investment if the mobile BTS has reached the premises.

B. Business model for telecom operators

The proposed solution will be a good business model for telecom operators. Besides getting the mobile subscribers, the mobile operators will also be able to serve the corporate customers like hospitals and clinics for the leased service. Technological changes in the wireless mobile network from 2G, 3G, 4G to IMS will add more benefit to the operators as it will be easier to provide new services like Centrex systems and VPNs for the purpose of telemedicine.

C. Electricity

Electricity is highly inconsistent in rural areas of India [10] with voltage fluctuation and daily load shedding (black outs for several hours). This is due to insufficient electricity production demanded by the consumers of the country. Operation of any electronic equipment requires constant power supply. For this huge investment on a power backup

system such as Uninterrupted Power Supplies (UPS) with batteries, standby generators and solar power systems will be required at the equipment sites. These power backup systems are mandatory for mobile telecommunication operators in rural areas to keep their BTSs up and running 24 hours a day. Hence, for the leased line communication, the hospitals do not need to worry about their communication system going out of service due to power outages. The rural hospitals will still need to prepare their own power backup system for their telemedicine equipment; however, many do not require constant a power supply. For example, computers, cameras, microscopes, etc may be switched off during hours when no one is using the telemedicine service. Thus, lower investment on power backup system will suffice in the hospitals. The heavy cost burden on power backup system will be faced by the mobile operators instead of the hospital.

VI. Discussion

Communication networks play a vital role in all the different types of telemedicine systems. It is not possible for medical entities to build their own communication networks for the purpose of telemedicine. Network infrastructure sharing should be done with telecom service providers.

Leased bandwidth connectivity using expanding mobile infrastructure for telemedicine in rural areas is the most cost-effective solution for the present scenario in India. Telemedicine equipment often requires a longer, stable connection to a fixed number of systems, for example, a rural hospital connected to a super specialty hospital; leased line connections suit this type of network requirement for both real-time and store and forward types of telemedicine applications. Since mobile networks are growing in the rural areas in India, further utilization of telemedicine services will be easier if leased connections can be provided through the BTS sites in the rural areas.

For this type of leased line service for a telemedicine network, a major role will be played by the telecom operator. Telecom operators should be ready for providing leased bandwidth service through their transmission network from their BTS sites. There will be issues of reliability in the leased network that will additionally require maintenance by the telecom operator.

India has 10 different telecom operators all over the country, but not all the operators will reach all the rural villages. Hence, different hospitals at different rural places will get connected with different telecom operators. Interoperability between the operators for leased connections will also be a key issue. A governing body should play a role in standardization and ensuring interoperability regulations between the operators for leased connections. Telecom Regulatory Authority of India (TRAI) should play a role in the provision of the leased connections for health services at fair prices by the telecom operators at rural places.

VII. Conclusion

Telemedicine has a wide range of applications in developing countries like India where the medical resources and professionals are insufficient. As medical facilities are centralized in highly populated cities, telemedicine provides easily accessed, quality medical services to rural areas. Quite possibly, the biggest advantage for growth in telemedicine is the boom in IT sectors worldwide. In India, the IT industry is booming as mobile networks and high bandwidth optical links will reach most of the remote villages in very near future. Using mobile infrastructure for telemedicine in rural areas will be the most beneficial solution. With the help of telemedicine, better health facility can be served to the poor communities of the rural villages and enhance their living standard.

References

1. Department of Telecommunications, Ministry of Communication & IT, Government of India (2010) Annual Report 2010, New Delhi.
2. Health Line, Okhla. Medical tourism India. at http://www.medical-tourism-india.com
3. PricewaterhouseCoopers (2007) Emerging Market Report: Health in India 2007
4. The financial express (July 2005) at http://www.financialexpress.com/news/doctorpopulation-ratio-stands-at-11-722/139534
5. Apollo Telemedicine Network Foundation. Services at http://www.telemedicineindia.com/Services.htm
6. CISCO newsroom (May 2010) at http://newsroom.cisco.com/dlls/2010/prod_050710b.html
7. ISRO (2010) at http://www.isro.org/scripts/telemedicine.aspx
8. Cellular Operators Association of India. (November 2010) Annual Report on Cellular Operators Association of India 2009-10 at http://www.coai.in
9. S.K. Mishra, D. Gupta, and J. Kaur (June 2007) Telemedicine in India: Initiatives and vision, e-Health Networking, Application and Services, pp 81-83, DOI. 10.1109/HEALTH.2007.381608
10. S. Surana, R. Patra, S. Nedevschi, and E. Brewer, (2008) Deploying a Rural Wireless Telemedicine System: Experiences in Sustainability, vol. 41, Computer, no. 6, pp 48-65, DOI: 10.1109/MC.2008.184

Author: Ujjwal Bania
Institute: Center for TeleInFrastruktur (CTIF), Aalborg University
Street: Fredrik Bajers Vej 7, 9220, Aalborg
City: Aalborg
Country: Denmark
Email: ujjwal.bania@gmail.com